

# **SURGICAL CLIP WITH A SELF-RELEASING FLUID RESERVOIR**

## Field of the Invention

The present invention generally relates to surgical clips used to secure tissue together. More specifically, the present invention relates to surgical clips with a self-releasing reservoir to deliver therapeutic materials.

## Background of the Invention

The present invention relates to clips for surgical procedures. Surgical clips are routinely used to secure tissue together during or after many differing surgical procedures. In most instances, a surgical procedure will result in at least one incision that requires closing. In addition, damaged or broken blood vessels, ligaments, bone, tendons, skin and other tissues may also require a means for securing. Surgical clips, preferably, are used to perform the function of securing these and other tissues together.

Surgical clips are known in the prior art and are available in a wide variety of shapes and styles. Generally, the clips comprise one or two pieces. In the case of one-piece clips, the clip will typically fold and lock onto itself while holding tissue in the fold. Similarly, two-piece clips typically secure tissue by holding tissue between the clips when they are brought together. In addition to clips, other devices are known in the prior art that are used to secure tissue together. These devices include clamps, staples, sutures, etc.

Surgical clips generally secure tissue together in the hope that the tissue will then fuse together over a period. In order to facilitate this process, it is often necessary to administer a therapeutic agent to assist with the repair of the tissue. The therapeutic agent may include sclerosing agents or pharmacological drugs.

Sclerosing agents are believed to irritate tissue, which in turn encourages the tissue to heal. Using a surgical clip in conjunction with a sclerosing agent may facilitate healing. Presently, a therapeutic agent needs to be delivered independently of using surgical clips. For example, a physician can administer a therapeutic agent to a desired area before or after securing tissue together. Surgical clips that possess the ability to deliver a sclerosing agent to tissue in need of being secured together could improve these processes and offer enhanced convenience.

Additionally, it may be necessary to administer a pharmacological agent. In general, it may be desired to administer a drug that can promote hemostasis. These drugs may promote healing by increasing adhesion and activation of platelets, increasing fibrin formation, or increasing vascular contraction. Typically, a physician may administer a pharmacological agent to an area of interest before or after securing tissue together. By combining the ability to secure tissue and to deliver a pharmacological drug, the process of clipping tissue may be more convenient and the over-all treatment improved.

Further, many modern surgical techniques are designed to be as non-invasive as possible. For these surgical techniques, specialized equipment is used that minimizes the size of an incision. For example, specialized clips and clipping techniques are required. Specialized clips are known that enable the joining of tissue when accessibility is limited. For example, clips are known that can be inserted into an incision in order to join ends of tissue below an incision. However, the delivery of a therapeutic agent would still need to take place independently of using the clip. The delivery of a therapeutic agent would, therefore, require additional specialized equipment. A need, therefore, exists for surgical

clips sized for specialized medical procedures that can deliver therapeutic agents such as a sclerosing agent or pharmacological drug in conjunction with medical procedures.

### Summary of the Invention

The present invention generally relates to surgical clips used to secure tissue  
5 together. In a preferred embodiment, a surgical clip comprises a first piece, a second piece, and a self-releasing reservoir disposed within at least one of the pieces that is activated during clipping of tissue and allows for the delivery of a therapeutic agent.

According to a preferred embodiment, the first piece comprises a first base and a first projection extending from the first base. Preferably, the first base is generally  
10 circular. In an exemplary embodiment, the first projection extends substantially perpendicular relative to the first base and is generally cylindrical in shape. In preferred embodiments, the first projection includes a proximal portion and a distal portion. The proximal portion is preferably generally cylindrical having an outside diameter smaller than that of the first base. The distal portion of the first projection is preferably conical in  
15 shape and includes a distal end defined by the tip of the conical shape and a proximal end defined by the base of the conical shape. The conical shaped distal portion is a preferred means for penetrating the tissue to be clipped and a preferred means for interacting with the second piece of the surgical clip described below. The base of the conical shaped distal portion is preferably generally circular and of a diameter greater than the proximal  
20 portion of the first projection. As such, the base of greater diameter provides an edge or radially projecting edge surface relative to the proximal portion of the first projection, providing a surface which releasably secures the first piece of the clip to the second piece

as described in detail below. Preferably, the first piece is constructed of bioabsorbable materials.

In a preferred embodiment, the second piece comprises a second base and a second projection extending from the second base. Preferably, the second base is generally circular and of greater diameter than the second projection. According to a preferred embodiment, the second projection extends substantially perpendicular relative to the second base. In an exemplary embodiment, the second projection is generally cylindrical in shape. Preferably, the second piece is constructed of bioabsorbable materials.

In a preferred embodiment, the second projection further comprises a top surface, at least one side surface and a bottom surface. These surfaces define a reservoir. Preferably, the reservoir contains a selected amount of a therapeutic agent, for example a sclerosing agent or pharmacological drug.

According to a preferred embodiment, the first piece and the second piece are detachably connectable. Preferably, the first projection and the second projection are shaped suitably to mate when brought together. In a preferred embodiment, the second projection comprises a means to slidably receive the first projection. In an alternative embodiment, the first projection receives the second projection.

In a preferred embodiment, detachably connecting the first piece and the second piece allows the release of a therapeutic agent from the reservoir. According to a preferred embodiment, the front surface overlies the hollow reservoir. In an exemplary embodiment, the front surface comprises puncturable material so that connecting the first piece and the second piece allows at least the distal portion of the first projection to

pierce the front surface. Piercing the front surface preferably releases the therapeutic agent from the reservoir.

In a preferred embodiment, the second projection further comprises at least one aperture sized to allow the flow of a therapeutic agent out of the reservoir. According to  
5 a preferred embodiment, when the first piece and the second piece are detachably connected, a therapeutic agent can flow out from the reservoir through the apertures which are preferably located in the side wall between the top and bottom surfaces.

In a preferred embodiment, tissue in need of being secured can be secured together by placing the first piece and the second piece in the proximity of the tissue.  
10 Preferably, when the first piece and the second piece are detachably connected, they secure the tissue together. Detachably connecting the first piece and the second piece results in the flow of a therapeutic agent from the reservoir to an area of interest proximate a tissue in need of being secured. In an exemplary embodiment, when the first piece and the second piece are connected, a therapeutic agent is released from at least one  
15 aperture contained within the second projection.

According to multiple embodiments of the current invention, tissue in need of being secured together may include, but is not limited to, a blood vessel, a ligament, a bone, a tendon, and skin. In an exemplary embodiment, the surgical clips can be sized for specialized surgical techniques. Preferably, the clips can be small enough to enter an  
20 incision in order to join tissue below the incision. A person of ordinary skill in the art would be familiar with determining tissue appropriate for multiple embodiments of the current invention.

### Brief Description of the Drawings

Figure 1 is a perspective cross-sectional view depicting a surgical clip according to a preferred embodiment of the current invention;

Figure 2 is a cross-sectional view of the surgical clip of Figure 1 depicting an arrangement appropriate for detachably connecting a first piece and a second piece; and

Figure 3 is a cross-sectional view of the surgical clip of Figure 2, wherein the first piece and the second piece are detachably connected and a therapeutic substance is released therefrom.

### Detailed Description of the Preferred Embodiments

Referring now to the drawings wherein like reference numerals indicate like elements throughout the several views, Figure 1 depicts a surgical clip according to a preferred embodiment of the current invention. Preferably, the surgical clip can be used in conjunction with a medical procedure to secure tissue together. In an exemplary embodiment, the surgical clip can be used to secure tissue together and concurrently deliver a therapeutic agent.

In a preferred embodiment, surgical clip 10 comprises first piece 12 and second piece 14. First piece 12 and second piece 14 are preferably constructed of bioabsorbable materials. Bioabsorbable materials can include, but are not limited to, poly(L-lactide) (PLLA), poly(D,L-lactide) (PLA), poly(glycolide) (PGA), poly(L-lactide-co-D.L. Lactide) (PLLA/PLA), poly(L-lactide-co-glycolide) (PLA/PGA), poly(glycolide-co-trimethylene carbonate) (PGA/PTMC), polydioxanone (PDS), polycaprolactone (PCL), polyhydroxybutyrate (PHBT), poly(phosphazenes), poly(D,L-lactide-co-caprolactone) (PLA/PCL), poly(glycolide-co-caprolactone) (PGA/PCL), poly(phosphate ester) and

polyanhydrides. A person of ordinary skill in the art would be familiar with choosing an appropriate material for constructing first piece 12 and second piece 14 according to multiple embodiments of the current invention. The materials could be selected from any biocompatible material for selected permanent or temporary application.

5            Preferably, embodiments of the invention include surgical clips sized for differing surgical procedures. In one preferred embodiment, surgical clip 10 can be sized appropriately to enter an incision in order to join tissue below the incision. One of ordinary skill in the art would be familiar with choosing an appropriate size of surgical clip 10 according to a selected use of the current invention.

10           First piece 12 further comprises first base 16 and first projection 18 extending from first base 16. First base 16 is preferably generally circular. According to a preferred embodiment, first projection 18 extends substantially perpendicular from first piece 12 relative to first base 16. Further, first base 16 is preferably of larger diameter than first projection 18 so that in use, first projection 18 is inserted through tissue which  
15 is to be secured, while first base 16 provides an enlarged planar surface 17 which contacts tissue proximate first projection 18 and holds it in place.

            Second piece 14 further comprises a second base 20 and a second projection 22 extending from the second base 20. In an exemplary embodiment, second base 20 is generally circular. Preferably, second projection 22 is substantially cylindrical in shape.  
20           According to a preferred embodiment, second projection 22 extends substantially perpendicular from second piece 14 relative to second base 20. As with first piece 12, second base 20 is preferably of larger diameter than second projection 22 so that in use, second projection 22 is inserted through tissue to be secured, while second base 20

provides an enlarged planar surface 21 which contacts tissue proximate second projection 22 and holds it in place.

In a preferred embodiment of the current invention, second projection 22 further comprises top surface 24, at least one side surface 26 and bottom surface 30. Bottom surface 30 preferably comprises a portion of second base 20. In an exemplary embodiment, second base 20 is hollow. In a preferred embodiment, top surface 24, side surface 26 and bottom surface 30 define reservoir 32 which, as previously stated, is preferably cylindrical in shape.

First piece 12 and second piece 14 are designed so that in use the two pieces cooperate to form a unitary, preferably releasably secured surgical clip 10 having enlarged planar surfaces 17 and 21 opposing each other and holding secured tissue therebetween. As depicted in Figure 1, structural features have been incorporated into first projection 18 and second projection 22 to provide means for securing the first piece 12 to the second piece 14. Second piece 14 includes second projection 22 which preferably is generally cylindrical in shape and having a hollow reservoir 32 therein. The top surface 24 of the second projection 22 preferably incorporates a rim portion 31 which includes an opening of diameter slightly smaller than the inside diameter of the cylindrical shape defined by the second projection 22. This rim member 31 cooperates with the first projection 18 of first piece 12 to secure the members together.

To cooperate with the above-described design of second piece 14, the first projection 18 preferably includes a proximal portion 19 and a distal portion 15. The proximal portion 19 is preferably generally cylindrical and has an outside diameter smaller than that of the base as described above. The distal portion 15 of the first



projection 18 is preferably generally conical in shape and includes a distal end 13 defined by the tip of the conical shape at a proximal end 11 defined by the base of the conical shape. The conical shaped distal portion is a preferred means for penetrating the tissue to be clipped and a preferred means for interacting with the second piece 14 of the surgical clip. The base 11 of the conical shaped distal portion 15 is preferably generally circular and of a diameter greater than the proximal portion 19 of the first projection 18. As such, the base 11 of greater diameter provides an edge or radially projecting edge surface relative to the proximal portion 19 of the first projection 18. This surface secures the two pieces of the clip together when this portion passes through the rim portion 31 of the second piece 14. Figure 3 depicts these pieces secured together as described.

Preferably, top surface 24 comprises a puncturable material portion 25 filling the opening through rim portion 31. According to a preferred embodiment, connecting first piece 12 and second piece 14, as described above, results in the puncture of puncturable material portion 25 of top surface 24. One of ordinary skill in the art would be familiar with puncturable materials appropriate for selected embodiments of the current invention. Bioabsorbable polymeric films would be especially suitable for use.

In a preferred embodiment, second projection 22 further comprises at least one aperture 23 sized to allow the flow of a therapeutic agent 34 out of reservoir 32. According to a preferred embodiment, detachably connecting first piece 12 and second piece 14 results in the release of a therapeutic agent through aperture 23.

In alternative embodiments, first piece 12 and second piece 14 are detachably connectable utilizing other known designs wherein second piece 14 comprises a cross-sectional profile adapted to mate with first projection 18 of first piece 12. In each

preferred embodiment, first piece 12 is adapted to pierce top surface 24 of second projection 22.

Reservoir 32, defined by second projection 22, preferably contains a predetermined amount of a therapeutic agent. The therapeutic agent may include, but is not limited to, a sclerosing agent or a pharmacological agent. For example, sclerosing agents may include; but are not limited to, sodium morrhuate, ethanolamine oleate, sotradecol, polidocanol, scleremo, hypertonic saline, sclerodex, and polyiodinated iodine.

Alternatively, for example, pharmacological agents may include, but are not limited to, vitamin K (phytomenadione), menadiol sodium diphosphate, warfarin, low-molecular-weight heparins (LMWHs), heparin, protamine sulfate, dermatan sulfate, and any other drug affecting hemostasis. Numerous pharmacological agents have been set forth in the foregoing description. It will be understood, however, that this disclosure is, in many respects, only illustrative and that multiple other pharmacological agents could be used in place of the list above.

Figure 2 is a cross-sectional view of a surgical clip in an arrangement appropriate for detachably connecting the first piece and second piece. First piece 12 and second piece 14 of surgical clip 10 are detachably connectable. First piece 12 comprises first projection 18 extending from first base 16. Second piece 14 comprises second projection 22 extending from second base 20. Second piece 14 further comprises top surface 24, side surface 26, and bottom surface 30 that define reservoir 32. In a preferred embodiment of the current invention, reservoir 32 contains therapeutic agent 34.

Preferably, first projection 18 and second projection 22 are shaped suitably to mate when brought together. In a preferred embodiment, second projection 22 comprises

a means to slidably receive first projection 18. In an alternative embodiment, first projection 18 slidably receives second projection 22.

In a preferred embodiment, detachably connecting first piece 12 and second piece 14 causes the release of therapeutic agent 34 from reservoir 32. According to a preferred  
5 embodiment, top surface 24 is hollow. In an exemplary embodiment, top surface 24 comprises puncturable material 25 over the opening in rim portion 31 so that connecting first piece 12 and second piece 14 allows first projection 18 to pierce top surface 24. Piercing top surface 24 preferably begins release of therapeutic agent 34 from reservoir 32 through apertures 23.

10 Figure 3 depicts the surgical clip of Figure 2, wherein the first piece and second piece are detachably connected.

Second piece 14 is depicted with a cross-sectional profile that is mated with first projection 18 of first piece 12. First piece 12 has pierced the top surface 24 of second projection 22. Planar surfaces 17 and 21 oppose each other to secure tissue 36 together.  
15 First projection 18 and second projection 22 pass through the tissue 36. As shown, therapeutic agent 34 has been released from reservoir 32 of second projection 22 through the at least one aperture 23.

According to multiple embodiments of the current invention, tissue 36 in need of being secured together may include, but is not limited to, a blood vessel, a ligament, a  
20 bone, a tendon, and skin. A person of ordinary skill in the art would be familiar with determining tissue appropriate for multiple embodiments of the current invention.

Numerous advantages of the invention covered by this document have been set forth in the foregoing description. It will be understood, however, that this disclosure is,

in many respects, only illustrative. Changes may be made in details, particularly in matters of shape, size, and arrangement of steps without exceeding the scope of the invention. The invention's scope is, of course, defined in the language in which the appended claims are expressed.

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